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CHANGES IN VEGETATION STRUCTURE IN SEEDED NESTING COVER IN THE PRAIRIE POTHOLE REGION

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Abstract

A sample of 365 stands of seeded nesting cover (mixtures of cool-season grasses and legumes) was studied in the glaciated prairie pothole region during 1977–79. Measurements of species composition, canopy cover, plant height, and visual obstruction values differed with stand age but only in a general way when results from over the entire region were pooled. Maximum values for plant height and visual obstruction occurred once per stand during the first 10 growing seasons. Although the year of maximum growth was variable and unpredictable, stands showed trends of degeneration in height and visual obstruction after the year of maximum growth.

Seeded nesting cover grew similarly throughout the region when on soils of capability class IV or better and within a precipitation range of 30 to 61 cm. Precipitation was the factor that most affected stand growth, especially the amount received in the year before spring measurements. Height and visual obstruction values within a stand were also directly affected by some individual species and by the percentage of grass within a stand. In 2 of the 3 study years, the height and visual obstruction values of residual cover were extremely reduced by ice pack, heavy snow pack, or a combination of snow pack and harvest by rodents. Such events, if frequent, largely negate the possibility of using minimum visual obstruction or plant height measurements for assessing quality of vegetation for wildlife cover and management purposes.

Species composition, number of species, and canopy cover varied most during the first three growing seasons and least during the next six. Succession toward dominance by native grasses and forbs and woody species was retarded by the predominance of the species of seeded nesting cover, at least during the first 10 growing seasons.

All stands had at least one species present that was either a noxious weed, a problem cropland weed, or a nuisance weed. Weeds were usually local in distribution. Five weed species needing special management attention on public lands are leafy spurge (*Euphorbia podperae*), wormwood (*Artemisia absinthium*), Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), and plumeless thistle (*Carduus acanthoides*). Sites disturbed by mammal diggings or those skipped during planting operations became revegetated mostly with species other than those of seeded nesting cover.

Successfully established stands on good sites provided substantial food and cover for wildlife for at least 6 years and retained stand composition for at least 10 years. Further study will be necessary to determine longevity of these stands. Except for mandatory noxious weed control, no management treatments of seeded nesting cover were necessary before the seventh growing season, at which time some stands needed renovation. The primary goals for management of seeded nesting cover should be stand quality and longevity. Guidelines to these goals are suggested.

The conversion of natural grasslands of the Northern Great Plains into man-induced and -managed plant communities began in the 1800's and still continues. If these man-induced and -managed plant communities are grown on essentially the same physical sites as earlier endemic plant communities, they are known as "replacement plant communities" (Mueller-Dombois and Ellenberg 1974). As early as 1747, red clover (*Trifolium pratense*) was sown as a replacement community on previously tilled soil in North America and by the late 1700's there was considerable interest in forage grasses and legumes from England (Heath 1973). The use of forage grasses and legumes in North American agriculture continued gradually until the late 1920's and then expanded rapidly in the 1930's and early 1940's during the nationwide soil conservation and protection movement in response to drought.

After World War II small grains gained prominence in American agriculture and by the end of the decade, production began to exceed demand. However, starting in the mid-1950's the U.S. Department of Agriculture (USDA) initiated several cropland retirement programs whereby tame grasses and legumes were sown in efforts to help ameliorate a surplus of grain. Two of these programs were the Soil Bank Program (Peterson 1956) of the late 1950's and early 1960's and the Cropland Adjustment Program (Jaenke 1966) of the late 1960's and early 1970's. Some beneficial values of these programs to wildlife in the prairie pothole region were reported by Schrader (1960), Benson (1964), Jessen et al. (1964), Moyle (1964), Dahlgren (1967), Drewien and Springer (1969), Duebbert (1969), Harmon and Nelson (1973), Kirsch et al. (1973), Duebbert and Kantrud (1974), Kirsch (1974), and Duebbert and Lokemoen (1976, 1977, 1980). Stewart (1975) reported 37 species of birds that used tame grass–legume plant communities to satisfy some or most of their habitat requirements; 29 of these plus 5 others are known to use sown stands for nesting (Table A-1).

In 1978, 120,125 ha (Table A-2) of seeded nesting cover (SNC) were provided for wildlife on privately owned land in the glaciated prairie pothole region through the USDA's Water Bank Program (Phillips 1975; Womach 1977). I estimate that about 40,500 ha are provided for wildlife on other State, Provincial, and Federal lands in this region. The principal replacement community (SNC) presently being established on the Water Bank Program and refuge lands is a mixture of introduced cool-season grasses and legumes. This mixture generally includes intermediate wheatgrass (see Table A-3 for scientific names of plants), tall wheatgrass, alfalfa, and sweet clovers. Occasionally, a few managers included a supplemental amount of western wheatgrass, slender wheatgrass, crested wheatgrass, green needlegrass, or switchgrass in the seeding mixture. Recent studies of relations of wildlife to combinations of this particular mixture have been reported by Duebbert (1969), Duebbert and Kantrud (1974), Nelson and Duebbert (1974), Cowardin and Johnson (1979), Kaiser et al. (1979), and Duebbert and Lokemoen (1976, 1977, 1980). They found that (1) the mixture is economical to establish, (2) it can be sown or broadcasted on previously tilled land with the commonest of commercial farm equipment, (3) it generally supports greater nest densities and higher hatch rates for many upland nesting bird species than adjacent habitat types, (4) it is capable of producing wildlife during the first several years of secondary plant succession, and (5) the wildlife values seem to have some relation to the growth form and composition of the vegetation.

A recent concern of land managers is whether this type of seeded nesting cover will degenerate in composition, cover, height, and denseness, and if so, will degeneration occur in a consistent pattern or in a time-predictable manner. The present study was initiated in 1976; its objectives were (1) to determine whether any consistent patterns of change occur in species composition, canopy cover, plant height, and visual obstruction within vegetation cover during secondary succession of the seeded mixture (SNC) in known age stands and (2) to determine the influence of species other than the seeded mixture on the stability of SNC stands during early succession.

Materials and Methods

Study Areas

All study areas were either on National Wildlife Refuge or Waterfowl Production Area land and had known-aged stands of SNC. Their distribution ranged from the southern edge of eastern South Dakota to the northern boundary of North Dakota and from west central Minnesota to the extreme northeast corner of Montana (Fig. 1). A moisture gradient represented by a gradual increase in annual precipitation from about 30 cm in the Northwest to about 64 cm in the East and Southeast extends across the region.

All stands were sown on uplands suitable for cultivation, based on Soil Conservation Service guidelines. Study area stands were found on a large variety of upland soils and all were within the following capability classification groups:

Class II. — Soils with some limitations that reduce choice of crops or require moderate conservation treatments.

Class III. — Soils with severe limitations for cropland use that reduce choice of crops and require special conservation treatments, particularly for erosion control.

Class IV. — Soils with very severe limitations for cropland use that limit choice of crops and require very careful management, particularly in control of erosion.

Stand Selection Criteria

Selection of stands was based on two criteria: (1) each stand or field had to consist of a unit of land with a recent history of tillage and a sown mixture of grasses and legumes, and (2) stands could not have been altered by till-

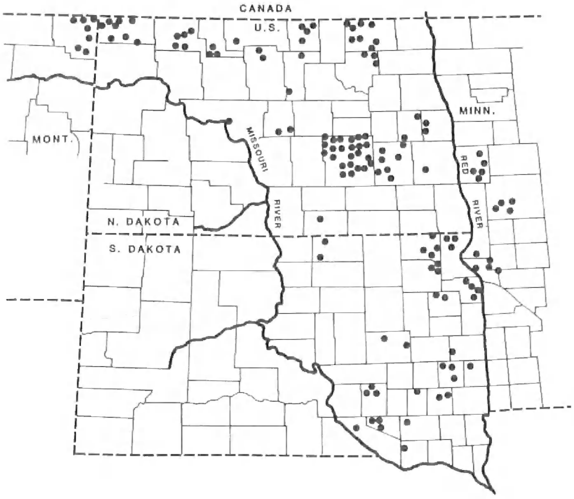

Fig. 1. Distribution of stands of seeded nesting cover sampled in Minnesota, Montana, North Dakota, and South Dakota.

age, vegetation removal practices, or fire after the nurse crop was sown and harvested. This generally implies no treatment after the first year of growth. The principal species sown included alfalfa, yellow and white sweet clover, and intermediate and tall wheatgrass. Occasionally, a stand's mixture would also include a small amount of western wheatgrass, slender wheatgrass, crested wheatgrass, green needlegrass, or switchgrass.

An inventory of land and water on National Wildlife Refuges and Waterfowl Production Areas in the glaciated prairie pothole region was made in 1976 and updated in 1978 and 1979 (K. F. Higgins and D. A. Davenport, 12 July 1979, unpublished data). A base of 65,205 ha on 2,352 management units with a recent tillage history, potential sites for SNC establishment, was identified in this inventory. In 1976, about 14% or 9,072 ha met selection criterion 1 for SNC and essentially all had been sown since 1968.

During winter 1976–77, refuge and wetland district managers were asked to help identify stands that met selection criteria 1 and 2. A total of 327 stands appeared to fit the criteria for selection. Unfortunately, only 83 of these stands met both criteria when visited during the 1977 field season. This initial discrepancy in field selection was primarily the result of two factors: (1) an emergency mandate to release units of public-owned grasslands for livestock forage and hay to ameliorate the effects of extreme drought and low herbage production in this region during 1976 and (2) a high transfer rate in refuge personnel.

After the 1977 field season, another search of the updated files plus the annual increment of newly established stands increased stand samples to 138 in 1978 and 144 in 1979. Some stands were not sampled each year because the vegetation had been subjected to damage by intensive hailstorms or by tillage operations.

Transect Location

The prevailing wind direction in this region during fall and winter is from the northwest. Aerial viewing of several stands revealed a greater penetration of snowdrifts into the cover along the north and west edges. Therefore, vegetative transects were not located parallel to the north or west field edges. Transects did not conform to a specific direction or length because of the high degree of irregularity in stand size, perimeter, and shape, but were aligned with some obvious nearby physical features within or adjacent to each stand. These physical features were selected from either aerial photographs or surveyors maps, or by cruising the periphery of a stand. They were always selected before measurement of vegetation within a stand. The transect, the physical features, the spacing interval between measurement points, and the direction of measurements were all identified on field maps to assure a similar degree of repeatability during later visits.

The length of transects ranged from 150 to 375 m and averaged about 200 m. The length varied in relation to stand size and spacing between stations of measurement. Stations of measurement for residual cover samples were equidistantly spaced 6 steps apart in stands of less than 4 ha and 10 steps apart in larger stands. Measurements of live vegetation were taken at even numbered stations for residual cover measurements.

Vegetation Data Collection

Five types of vegetative data were recorded annually along a linear transect in each stand, two types of residual cover measurements during early spring and three types of foliage records during summer. An effort was made to measure the same plots in each transect for both residual and live vegetation during all years.

Between 15 March and 15 May, 100 visual obstruction measurements (Robel et al. 1970), 4 at each of 25 stations, and 25 height measurements (Jagtenberg 1970), 1 at each of 25 stations, were made per transect in the residual plant cover. In a few stands, measurements were taken at less than 25 stations due to unforeseen circumstances. Visual obstruction measurements were read on a 1.5-m by 5-cm-square pole from a distance of 4 m and a sighting height of 1 m. The pole was painted white with decimeter and half-decimeter graduations and numerals painted red (Fig. 2), a slight modification of the pole description given by Robel et al. (1970). A visual obstruction value was read at a point on the pole where the residual vegetation began to hide the pole and no other part of the pole could be seen below this point. Measurements were rounded to the nearest half-decimeter. Height measurements were made by sliding a slotted 30-cm-diameter by 3-mm-thick plastic

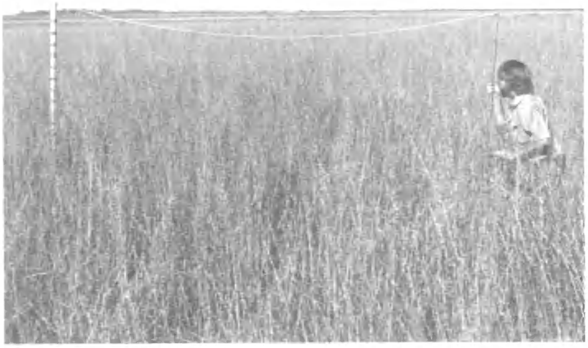

Fig. 2. A pole was used to measure the visual obstruction of residual vegetation.

Fig. 3. A 30-cm-diameter plastic disc was used to measure the height of residual vegetation.

disc (Fig. 3) down the pole until the first piece of residual vegetation touched the bottom or edge of the disc. A height value was read at this point on the pole and rounded to the nearest half-decimeter.

Between 1 July and 31 August, three sets of data were recorded for live plants within a square meter quadrat at 12 stations per transect. These data sets included (1) a list of species present per transect, (2) an estimate of the percentage composition of a plant species relative to all plant species within a quadrat (Brown 1954), and (3) an estimate of canopy coverage expressed as the percentage of ground area covered by the vertical projection of the maximum spread of foliage (Cain 1932) of the above-ground parts of each species per quadrat (Brown 1954; Mueller-Dombois and Ellenberg 1974). No reduction adjustment was made for the small open spaces occurring in a canopy. The sum of percentage cover for all species within a quadrat could exceed 100% because of vertical structural stratification of the various plant species. A supplemental list was also kept of the plant species that occurred along each transect but not within the square meter quadrats.

Scientific plant names correspond with the Atlas of the Flora of the Great Plains (Great Plains Flora Association 1977). Table A-3 lists all plant species by name and presents growth habit indices.

Data Units and Analysis

The original data were coded for keypunching and tabulated with the aid of Statistical Analysis System computer programs (SAS Institute Inc. 1979).

Descriptive parameters for each species in SNC stands were estimated within square meter quadrats as follows:

$$\text{percent frequency} = \frac{\text{number quadrats in which a species occurred}}{\text{total number of quadrats}} \times 100$$

$$\text{relative frequency} = \frac{\text{number quadrats in which a species occurred}}{\text{total no. quadrats in which all species occurred}} \times 100$$

$$\text{percent canopy cover} = \frac{\text{estimated percent of ground area covered by a vertical projection of the canopy spread of a species} \times 100}{}$$

$$\text{relative canopy cover} = \frac{\text{estimated \% ground area covered by a species}}{\text{estimated \% ground area covered by all species}} \times 100$$

$$\text{percent composition} = \frac{\text{estimated number of a species in a quadrat}}{\text{estimated numbers of all species in a quadrat}} \times 100$$

$$\text{importance value} = \frac{\text{relative frequency + relative canopy cover + relative composition}}{}$$

The sum of the importance values for all species in a stand sample equalled 300%. Importance values are synthetic values commonly used to position or rank a species within a stand or community or among different kinds of stands or communities.

Twenty different measures were analyzed for their relation to visual obstruction measurements taken in the same stand: seven measures of precipitation (the long-term average, total from initial planting year to measurement year, total from initial planting year to measurement year plus 1 year before planting, the previous year plus the initial year, the year before planting only, the 2 years before planting, and the standardized, expressed as the previous year's precipitation minus the long-term average divided by the long-term average); three soil classes (soil capability Class II, soil capability Class III, and soil capability Class IV); the percentage of grass estimated per stand; and nine age classes representing the nine growing seasons since planting.

Scatter-plot diagrams indicated little or no relation between visual obstruction and height measurements and the first six precipitation variates. The seventh or the stand-

Table 1. *Comparative differences of visual obstruction and height measurements of residual vegetation among stands dominated by tall wheatgrass, stands dominated by other wheatgrasses, and all stands, 1977–79.*

Year and category	Number of stands	Number of obstruction measurements	$\bar{X}$	Number of height measurements	$\bar{X}$
1977					
Tall wheatgrass	16	1,448	2.6	362	8.7
Other wheatgrasses	67	6,008	2.1	1,408	7.2
All	83	7,456	2.2	1,770	7.5
1978					
Tall wheatgrass	26	2,564	1.0	641	6.4
Other wheatgrasses	112	10,407	0.8	2,620	4.9
All	138	12,971	0.8	3,261	5.2
1979					
Tall wheatgrass	32	3,100	1.5	775	7.4
Other wheatgrasses	112	11,140	1.1	2,785	5.7
All	144	14,240	1.2	3,560	6.1

ardized precipitation appeared related and thus was the only precipitation variate used in the analysis.

A repeated measures analysis of covariance was performed with the computer program BMDP2V (BMDP 1977) to relate the dependent variable visual obstruction with standardized precipitation, soil class, percentage grass, and age. Repeated measures analysis was used because 58 stands were measured on the same sites in 3 consecutive years; consequently, the measurements were not independent from year to year. The visual obstruction values were transformed by taking the square root to stabilize the variance.

An analysis of variance program (SAS Institute Inc. 1979) was used to test the relation of the dependent variable's visual obstruction and height with the stand age and sample location within each transect and by year.

Results

Attributes of Residual Vegetation

In 1977 mean visual obstruction per stand ranged from 0.6 to 4.3 dm and averaged 2.2 dm, and mean height per stand ranged from 3.2 to 17.0 dm and averaged 7.5 dm (Table 1). The 4-year-old stands of SNC in 1977 averaged higher visual obstruction than did stands in other age classes (Fig. 4A). Except for the 2-year-old stands, plant height was also greatest in the 4-year-old age class (Fig. 4B). Greater height occurred in the 2-year-old stands mainly because sweet clovers, very tall species, were an important component of the vegetation in this age class.

In 1978 mean visual obstruction per stand ranged from 0.2 to 2.2 dm and averaged 0.8 dm, and mean height per stand ranged from 1.9 to 9.9 dm and averaged 5.2 dm (Table 1). In 1978, when sweet clovers were predominant, the visual obstruction averaged higher in the 3-year-old stands (Fig. 4C) and plant height averaged higher in the 2-year-old stands (Fig. 4D).

In 1979 mean visual obstruction per stand ranged from 0.4 to 3.4 dm and averaged 1.2 dm, and mean height per stand ranged from 1.9 to 11.7 dm and averaged 6.1 dm (Table 1). The 5-year-old stands of SNC averaged higher visual obstruction than did stands in other age classes (Fig. 4E). Except for the 2- and 3-year-old stands, plant height was also greatest in the 5-year-old age class stands (Fig. 4F).

There are four plausible reasons for the dissimilar trends of cover height and obstruction between the 1977, 1978, and 1979 data sets: (1) an early and heavy snowfall occurred over much of the region during 7–9 November 1977 and remained all winter (some areas in Minnesota and South Dakota accumulated more than 100 cm); (2) an ice storm occurred in central North Dakota during 15–19 December 1977; (3) most of the older stands had just endured nearly 2 years of extreme drought during 1976 and 1977; and (4) the 1979 measurements were somewhat reduced because of the effects of a heavy snow cover and the harvesting of vegetation by rodents, mainly meadow voles, *Microtus* spp. (Fig. 5). Storms and drought are believed largely responsible for the lower residual cover and the reduced structure of the vegetation in SNC stands throughout much of the study region in 1978.

Factors Affecting Visual Obstruction Measurements

Tall Wheatgrass Versus Other Wheatgrasses

Fields with predominantly more tall wheatgrass withstood the effects of winter and climatic elements better than fields dominated by other wheatgrasses (Fig. 6). In 1977–79, stands dominated by tall wheatgrass averaged

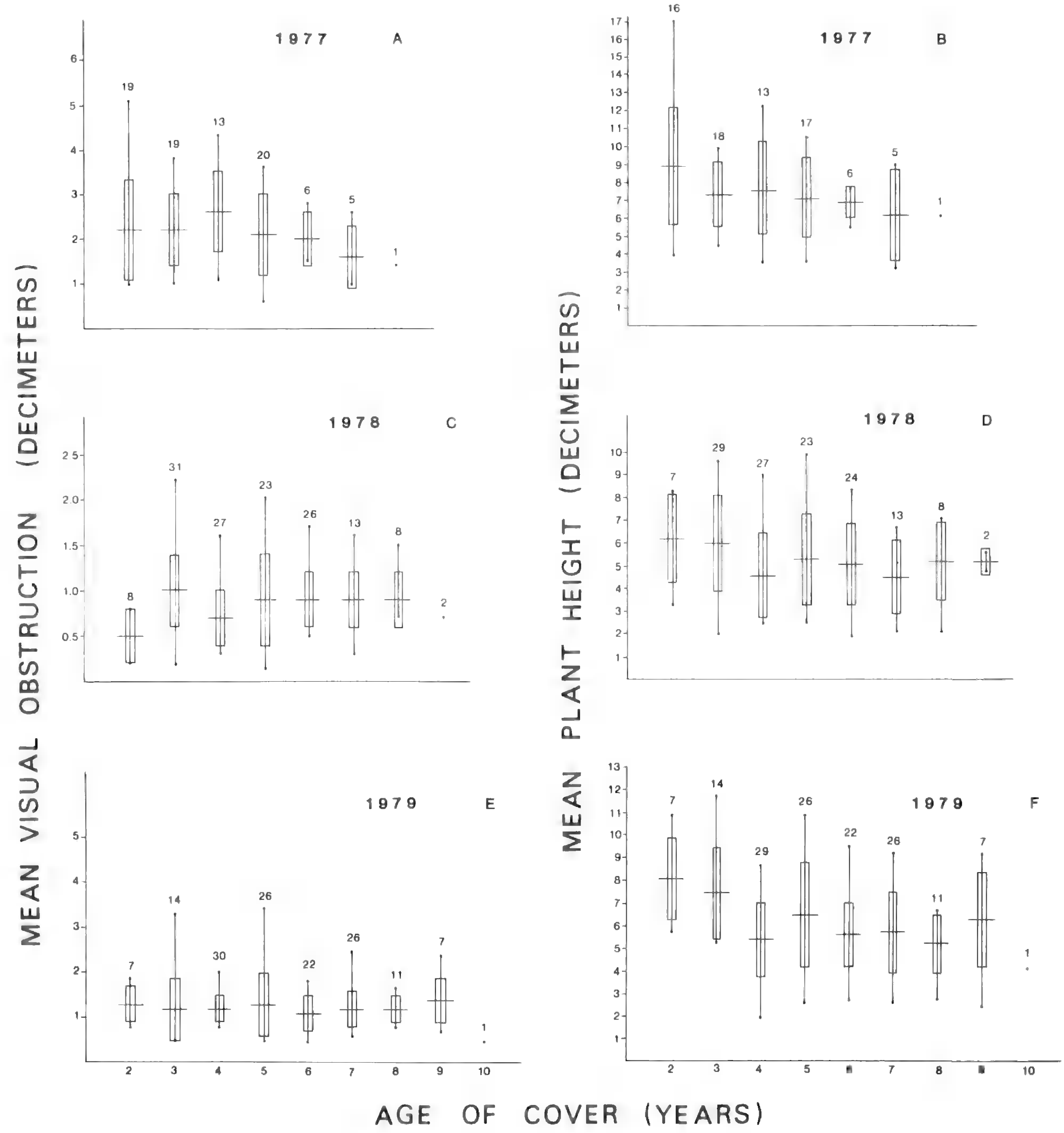

Fig. 4. Visual obstruction and height measurements ± one standard deviation, mean, and range per age class of residual seeded nesting cover during spring, 1977–79. Sample size appears above the range lines.

greater in visual obstruction and plant height than did stands dominated by other wheatgrasses (Table 1).

Age, Soils, Precipitation, and Percent Grass

Correlation coefficients for the relation between height measurements and visual obstruction measurements were significant for 58 stands in 1977 ($r = 0.74$), 119 stands in 1978 ($r = 0.52$), and for 128 stands in 1979 ($r = 0.65$).

Repeated measures analysis of covariance indicated that visual obstruction measurements were not significantly influenced by the soil capability class or by the age class (Table 2). However, the covariates, percent grass and

Fig. 5. Example of harvest effects on plants by meadow voles during winter 1978–79.

Fig. 6. Tall wheatgrass and switchgrass (left) structurally withstood the effects of a winter snowpack better than intermediate wheatgrass and quackgrass (right) as shown in spring 1978.

standardized precipitation, did have significant effects (Table 2).

The visual obstruction increased significantly among stands as the percent grass increased in relation to plant species composition (Table 2). Visual obstruction was also significantly influenced by standardized precipitation.

Differences among visual obstruction measurements within stands were significant from year to year. These differences also corresponded with changes in standardized precipitation but not with changes of percent grass (Table 2).

Attributes of Live Vegetation

Vegetative Characteristics of All Species Within Stands

Ten species of plants were sown in various SNC fields during stand establishment. Ninety-nine plant species were found in SNC stands in 1977, 135 in 1978, 130 in 1979, and 159 species in all years combined (Tables 3 and A-3). Of the 159 plant species, 60% were of native origin, 60% were of perennial growth habit, and 79% were of forb life form (Table 4).

Vegetative Characteristics of Species Within Quadrats

Of the 159 plant species found in 321 SNC stands, 115 occurred in at least 1 quadrat. Frequency, canopy cover, and composition values for these 115 species were given by Higgins (1981). Alfalfa, intermediate wheatgrass, tall wheatgrass, and quackgrass were consistently dominant among the 115 species in all years.

Aggregated values for life-forms.—A comparison of species frequency, canopy cover, and composition was made for the three major life-form groups (Table 5). Compared with grasses and forbs, shrubs and tree saplings were of minor importance in all stands. Forbs appeared in slightly greater relative frequency than grasses (53.2 vs. 44.6%) but grasses provided slightly more relative canopy cover than forbs (52.0 vs. 47.4%). Grasses made up a majority (80.8%) of the total species composition.

Table 2. *Analysis of covariance for repeated measures analysis of visual obstruction measurements.*

Source of variation	df	Mean square[a]	F[a]	P
Among plots				
Soil capability class	2	0.080	1.35	0.27
Average standardized precipitation	1	1.457	24.47	<0.0001
Average percent grass	1	0.640	10.76	0.0019
Age	1	0.009	0.16	0.69
Error	52	0.060		
Within plots				
Year	2	1.431	43.45	<0.0001
Year × soil capability class	4	0.013	0.38	0.82
Standardized precipitation	1	0.658	19.97	<0.0001
Percent grass	1	0.005	0.15	0.70
Error	108	0.033		

[a]Mean square and F are for H_0: Effect = 0 given all other effects are in the model.

Table 3. *Floristic richness in stands of seeded nesting cover in the glaciated prairie pothole region, 1977–79.*

Total seeded	Plant category	Total found 1977	1978	1979	Years combined
2	Families	24	32	32	36
5	Genera	65	93	87	105
10	Species	99	135	130	159

Table 4. *Comparison of characteristics of plant species seeded to those found in stands of seeded nesting cover in the prairie pothole region, 1977–79.*

Characteristic	Species seeded		1977 (N = 99)		1978 (N = 135)		1979 (N = 130)		Years combined (N = 159)	
	N	%	N	%	N	%	N	%	N	%
Origin										
Native	3[a]	30	54	55	78	58	77	59	96	60
Introduced	7	70	45	45	57	42	53	41	63	40
Growth habit										
Perennial	8	80	65	65	80	60	79	61	96	60
Annual	0	0	25	25	41	30	36	28	48	30
Biennial	2	20	9	9	14	10	15	12	15	9
Life-form										
Forb	3	30	75	75	108	80	103	79	126	79
Grass	7	70	19	19	20	15	19	15	24	15
Brush–shrub	0	0	3	3	3	2	4	3	4	3
Succulent	0	0	1	1	0	0	0	0	1	1
Tree	0	0	1	1	4	3	4	3	4	3

[a]Cultivars of native species.

Table 5. *Comparison of frequency, cover, and composition for three major life-forms of plant species in seeded nesting cover aggregated for 1977–79.*

Life-form	Percent frequency	Percent canopy cover	Relative frequency	Relative canopy cover	Percent species composition	Importance value
All grasses	45.4	48.9	44.6	52.0	80.8	177.4
All forbs	52.3	44.9	53.2	47.4	19.1	119.7
All shrubs	2.3	0.6	2.2	0.6	0.1	2.9

The trend in stand structure relative to age occurred in a similar fashion for shrubs, forbs, and grasses when expressed either in mean number of species, percentage canopy cover, or percentage composition (Fig. 7A–C). Shrub species had higher relative cover and composition during the first growing season and then nearly constant values in later years. Mean number of shrub species was nearly constant in all years. Grasses increased in number of species, canopy coverage, and species composition until the fourth growing season and remained nearly constant in later years. Forbs decreased in number of species, canopy coverage, and species composition until the fourth growing season and remained nearly constant in later years.

The contrasting expression in canopy cover, number of species, and species composition between grass and forb species appeared to indicate an almost reciprocal relation for these two major life-forms (Fig. 7D–F). In every age class this reciprocal expression suggests that for every quantifiable increase in the structure of grasses, forbs expressed an opposite quantifiable decrease in their structure and vice versa. This relationship was more or less constant, even though the total biomass may increase or decrease during the same time.

Age-related vegetation characteristics of stands. — The mean number of plant species for stands by age classes for groups of annuals, biennials, perennials, families, genera, species, introduced species, and native species were compared (Fig. 8A–J). The change in mean numbers of species for these groups was generally greatest during the first three growing seasons or age classes than during age classes 4 through 9.

Vegetative Characteristics of Selected Species Groups

Frequency, canopy cover, and composition were compared for three selected species groups: (1) 5 species comprising SNC, (2) 17 species of greater problem weeds of cropland, and (3) 15 species of regulated noxious weeds within the region (Table 6).

Seeded nesting cover species. — In relation to the 115 plant species occurring in at least one quadrat in the 321 stands, the 5 species of SNC made up 49.8% of the relative frequency, 75.0% of the relative canopy cover, and

Table 6. *Comparison of frequency, cover, and composition for three selected groups of plant species aggregated for 1977–79.*

Group	Number of species	Percent frequency	Percent canopy cover	Relative frequency	Relative canopy cover	Percent species composition	Importance value
Seeded nesting cover	5[a]	50.9	67.3	49.8	75.0	73.9	195.6
Problem farm weeds	17[b]	27.5	16.6	28.7	17.4	18.7	64.8
Noxious weeds	16[b]	16.9	13.0	16.2	14.0	16.5	46.6

[a]Includes alfalfa, intermediate wheatgrass, tall wheatgrass, white sweet clover, and yellow sweet clover.

[b]These two groups had four species in common: quackgrass, Canada thistle, field bindweed, and sow thistle. Other species of problem farm weeds and noxious weeds are listed in Table 7.

73.9% of the species composition (Table 6) and dominated over all other species except quackgrass.

Problem cropland weed species.—Quackgrass, Canada thistle, field bindweed, and sow thistle are recognized as problem cropland weeds and as regulated noxious weeds (Table 7). The other 13 problem farm weed species that are not also recognized as regulated noxious weed species made up 5.3% or less of the relative canopy cover, 1.9% or less of the species composition, and 9.2% or less of the relative frequency (Table 8).

Wild buckwheat, field bindweed, yellow foxtail, and western ragweed were problem cropland weeds that occurred commonly in SNC stands but they were not very obvious. Canada thistle, sow thistle, lamb's quarters, kochia, and Russian thistle also occurred commonly in SNC stands and were very obvious. Common and showy milkweed, annual sunflower, giant ragweed, wild oat, field mustard, and common pigweed were obvious species in SNC stands but they accounted for very little of the species composition or the canopy cover. Quackgrass was by far the most common and predominant weed species.

Regulated noxious weed species.—Fifteen species of noxious weeds are designated for legal regulation within the study region (Table 9). The regulated noxious weeds with the greatest relative values of frequency, canopy cover, and composition were quackgrass, Canada thistle, field bindweed, and sow thistle (Table 10). Quackgrass, which was governed by regulation only in South Dakota, was extremely common among these four species. Bull thistle was fairly common but not very obvious. Leafy spurge, wormwood, and plumeless thistle were not consistently present among stands but were usually dominant in the stands in which they occurred.

Only 8 of the 15 noxious weed species covered by regulation occurred in quadrat samples (Table 9). Russian knapweed, hoary cress, musk thistle, marijuana, horse nettle, perennial sow thistle, and poison ivy did not occur within the quadrat samples. However, musk thistle occurred in sample stands even though it did not occur within quadrats.

With the exception of quackgrass, noxious weed species (Table 10) accounted for 1.2% or less of relative canopy cover, made up 0.3% or less of the species composition, and 3.0% or less of the relative frequency. These values should be recognized as minimum estimates because sampling constraints excluded stands previously altered by grazing, haying, mowing, or spraying with herbicides. The quantitative values for frequency, canopy cover, and composition of regulated noxious weed species represented in Minnesota, Montana, North Dakota, and South Dakota were closely comparable (if quackgrass were deleted from the data set for South Dakota) among the four States (Table 11).

The cost of suppression of species of regulated noxious weeds and problem farm weeds is high. An example of such cost is given for various major land management agencies and for the private cropland operators for North

Table 7. *Comparison of problem cropland weeds with species of regulated noxious weeds in stands of seeded nesting cover.*

Problem cropland weeds	Regulated noxious weeds
Annual sunflower[a]	Yellow foxtail
Canada thistle	Bull thistle
Common milkweed	Canada thistle
Common pigweed	Field bindweed
Field bindweed	Hoary cress
Field mustard	Horse nettle
Giant ragweed	Leafy spurge
Kochia	Marijuana
Lamb's quarters	Musk thistle
Quackgrass	Perennial sow thistle
Russian thistle	Plumeless thistle
Showy milkweed	Poison ivy
Sow thistle	Quackgrass
Western ragweed	Russian knapweed
Wild buckwheat	Sow thistle
Wild oat	Wormwood

[a]Scientific names appear in Table A-3.

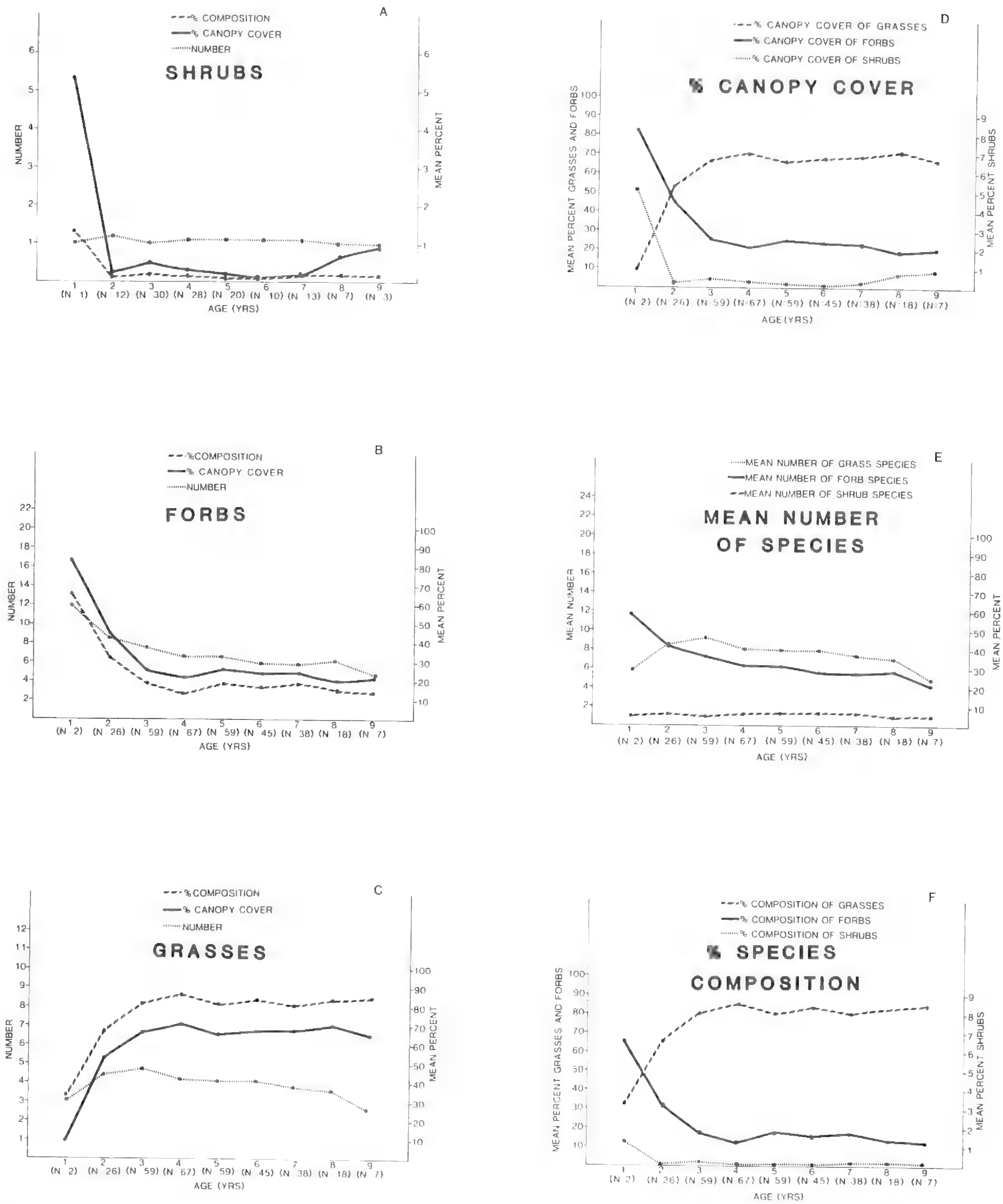

Fig. 7. Mean number of species, percent canopy cover, and percent composition for (A) shrubs, (B) forbs, and (C) grasses and comparisons of grasses, forbs, and shrubs by (D) percent canopy cover, (E) mean number of species, and (F) percent composition per age class for seeded nesting cover stands during 1977–79.

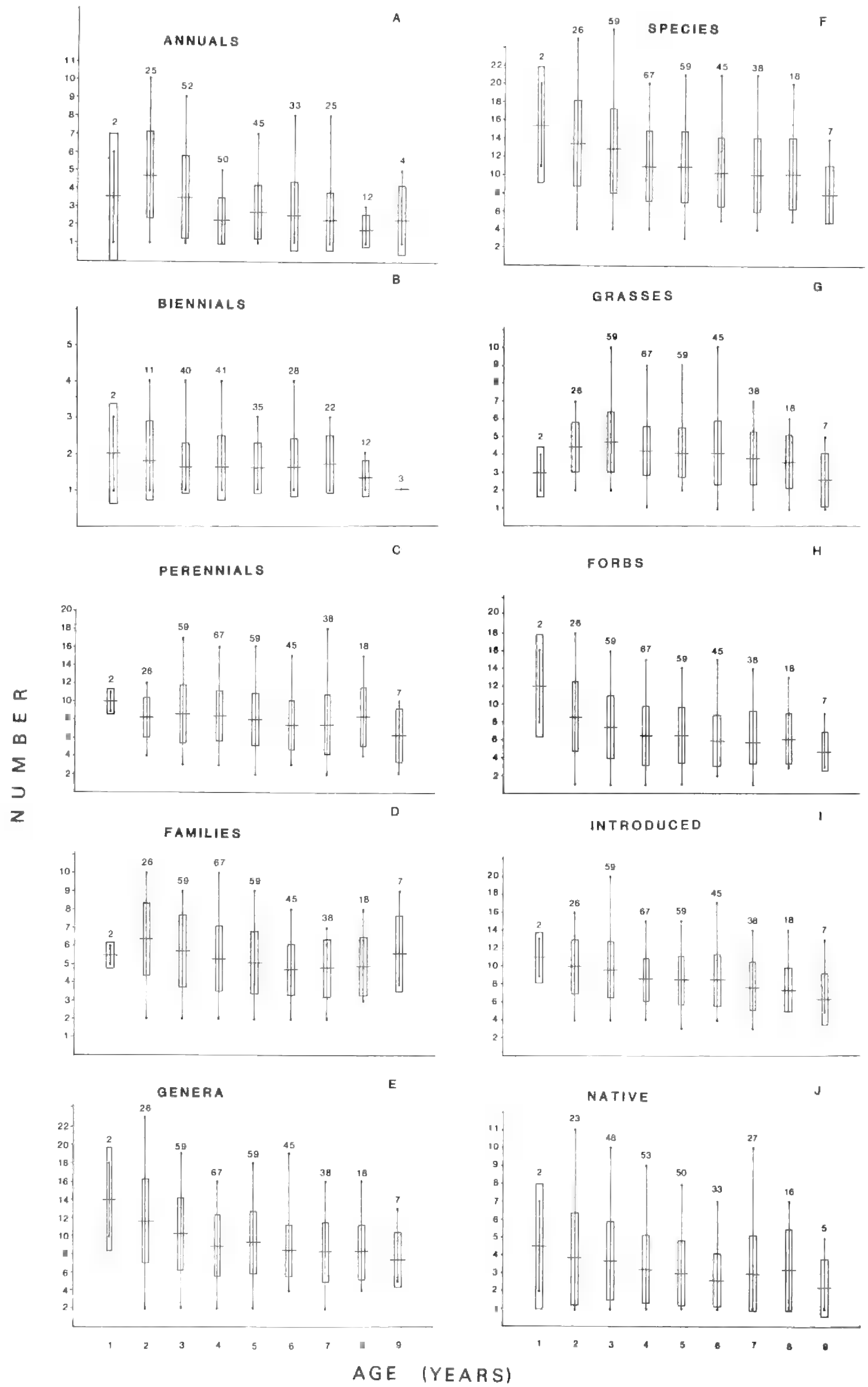

Fig. 8. Mean number of species ± one standard deviation, mean, and range of groups of vegetation characteristics per age class for seeded nesting cover stands during 1977–79. Sample size appears above the range line.

Table 8. *Frequency, canopy cover, and composition values for problem farm weeds in the study region.*

Species and year (N = 17)	Percent frequency	Percent canopy cover	Relative frequency	Relative canopy cover	Percent species composition	Importance value
Annual sunflower[a]						
1977	3.7	0.2	0.9	0.2	0.1	1.2
1978	0.4	T	0.1	T	T	0.1
1979	0.4	T	0.1	T	T	0.1
Canada thistle						
1977	7.0	0.5	1.6	0.4	0.1	2.1
1978	12.6	0.5	2.9	0.5	0.1	3.5
1979	13.0	0.6	3.3	0.8	0.2	4.3
Common milkweed						
1977	0.7	T	0.2	T	T	0.2
1978	1.5	T	0.3	T	T	0.3
1979	1.7	0.1	0.4	0.1	T	0.5
Common pigweed						
1977	0.2	T	T	T	T	T
1978	—	—	—	—	—	—
1979	—	—	—	—	—	—
Field bindweed						
1977	12.4	1.2	2.9	1.1	0.3	4.3
1978	12.4	1.0	2.9	1.1	0.2	4.2
1979	9.6	0.9	2.5	1.2	0.3	4.0
Field mustard						
1977	3.2	0.1	0.7	0.1	T	0.8
1978	0.7	T	0.2	T	T	0.2
1979	0.6	T	0.2	T	T	0.2
Giant ragweed						
1977	—	—	—	—	—	—
1978	0.1	T	T	T	T	T
1979	0.1	T	T	T	T	T
Kochia						
1977	3.7	0.2	0.9	0.2	0.2	1.3
1978	2.4	0.2	0.6	0.2	0.5	1.3
1979	0.5	T	0.1	T	T	0.1
Lamb's quarters						
1977	15.0	0.4	3.5	0.4	0.3	4.2
1978	2.2	0.1	0.5	0.1	T	0.6
1979	2.7	0.1	0.7	0.1	T	0.8
Quackgrass						
1977	28.1	11.4	6.6	10.2	11.7	28.5
1978	41.6	11.2	9.7	12.1	17.7	39.5
1979	38.0	9.3	9.7	12.0	18.3	40.0
Russian thistle						
1977	7.3	0.3	1.7	0.3	0.2	2.2
1978	0.7	T	0.2	T	T	0.2
1979	0.3	T	0.1	T	T	0.1
Showy milkweed						
1977	0.4	T	0.1	T	T	0.1
1978	0.1	T	T	T	T	T
1979	0.3	T	0.1	T	T	0.1

Table 8. Continued.

Species and year (N = 17)	Percent frequency	Percent canopy cover	Relative frequency	Relative canopy cover	Percent species composition	Importance value
Sow thistle						
1977	5.7	0.5	1.3	0.4	0.1	1.8
1978	8.3	0.9	1.9	1.0	0.2	3.1
1979	6.5	0.7	1.7	0.9	0.2	2.8
Western ragweed						
1977	9.5	0.7	2.2	0.6	0.3	3.1
1978	3.8	0.2	0.9	0.2	T	1.1
1979	3.5	0.1	0.9	0.1	0.1	1.1
Wild buckwheat						
1977	39.2	5.3	9.2	4.7	1.5	15.4
1978	12.5	0.3	2.9	0.3	0.2	3.4
1979	23.8	0.6	6.1	0.8	0.3	7.2
Wild oat						
1977	2.1	T	0.5	T	T	0.5
1978	0.7	T	0.2	T	T	0.2
1979	0.4	T	0.1	T	T	0.1
Yellow foxtail						
1977	11.4	1.5	2.7	1.3	1.9	5.9
1978	4.0	0.6	0.9	0.6	0.9	2.4
1979	3.7	0.2	0.9	0.3	0.2	1.4

Dakota during 1978 (Table 12). At present, the primary target species on public lands are leafy spurge, Canada thistle, wormwood, and sow thistle, all obvious weed species. The primary target species of problem weeds on private cropland are wild oat, quackgrass, yellow foxtail, Canada thistle, and field bindweed. Quackgrass is suppressed most of the time with proper tillage management, the others more by herbicides.

Vegetative Characteristics of Species Within Stands but not Within Quadrats

Of the 159 plant species found in 321 SNC stands, 44 species occurred within stands but did not occur within sample quadrats (Table 13). The number of species represented in each category of vegetative characteristic were life-form—34 forbs, 7 grasses, 1 tree, 1 shrub, and 1 succulent; growth habit—28 perennials, 11 annuals, and 5 biennials; and origin—28 natives and 16 introduced species. All 44 species occurred as trace (< 1 %) components of the SNC stands and most of the species were represented by a single specimen.

Vegetative Characteristics of Disturbed Sites Within Stands

Two kinds of disturbed areas were present in SNC stands, areas of exposed earth on mounds made by pocket gophers (*Geomys bursarius* and *Thomomys talpoides*), and badgers (*Taxidea taxus*), and areas originally left unsown because of skips made with seed drilling or broadcasting equipment.

Vegetation associated with earth mounds.—Twenty-five species of plants occurred on earth mounds made by

Table 9. *Noxious weeds regulated by State law in the glaciated prairie pothole region.*

Noxious weeds (N = 15)	Covered by law with regulation in North Dakota (N = 9)	South Dakota (N = 8)	Minnesota (N = 9)	Montana (N = 5)
Bull thistle[a]			X	
Canada thistle	X	X	X	X
Field bindweed	X	X	X	X
Hoary cress	X	X		X
Horse nettle		X		
Leafy spurge	X	X	X	X
Marijuana	X		X	
Musk thistle	X		X	
Perennial sow thistle	X	X	X	
Plumeless thistle			X	
Poison ivy			X	
Quackgrass		X		
Russian knapweed	X	X		X
Sow thistle	X	X	X	
Wormwood	X			

[a]Scientific names appear in Table A-3.

Table 10. *Frequency, canopy cover, and composition values for noxious weeds regulated by State law within the study region.*

Species and year	Percent frequency	Percent canopy cover	Relative frequency	Relative canopy cover	Percent relative composition	Importance value
Bull thistle[a]						
1977	–	–	–	–	–	–
1978	–	–	–	–	–	–
1979	0.1	T	T	T	T	T
Canada thistle						
1977	7.0	0.5	1.6	0.4	0.1	2.1
1978	12.6	0.5	2.9	0.5	0.1	3.5
1979	13.0	0.6	3.3	0.8	0.2	4.3
Field bindweed						
1977	12.4	1.2	2.9	1.1	0.3	4.3
1978	12.4	1.0	2.9	1.1	0.2	4.2
1979	9.6	0.9	2.5	1.2	0.3	4.0
Leafy spurge						
1977	0.2	T	T	T	T	T
1978	0.9	0.1	0.2	0.1	T	0.3
1979	0.5	T	0.1	T	T	0.1
Plumeless thistle						
1977	0.2	T	T	T	T	T
1978	0.3	T	0.1	T	T	0.1
1979	0.2	T	0.1	T	T	0.1
Quackgrass						
1977	28.1	11.4	6.6	10.2	11.7	28.5
1978	41.6	11.2	9.7	12.1	17.7	39.5
1979	38.0	9.3	9.7	12.0	18.3	40.0
Sow thistle						
1977	5.7	0.5	1.3	0.4	0.1	1.8
1978	8.3	0.9	1.9	1.0	0.2	3.1
1979	6.5	0.7	1.7	0.9	0.2	2.8
Wormwood						
1977	0.5	T	0.1	T	T	0.1
1978	1.5	0.1	0.3	0.1	T	0.4
1979	2.2	0.1	0.6	0.1	T	0.7

[a]Scientific names appear in Table A-3.

Table 11. *Frequency, canopy cover, and composition values for noxious weeds covered by law with regulation by States as averaged for 1977–79.*

State	Percent frequency	Percent canopy coverage	Relative frequency	Relative canopy cover	Percent species composition	Importance value
Minnesota	7.4	2.3	7.2	2.5	0.6	10.3
Montana	5.7	1.6	5.5	1.7	0.4	7.6
North Dakota	7.8	2.4	7.4	2.6	0.6	10.6
South Dakota[a]	16.4	12.9	15.8	13.9	16.5	46.2
South Dakota[b]	7.4	2.3	7.1	2.1	0.5	10.2

[a]Values with quackgrass included.
[b]Values with quackgrass excluded.

Table 12. *Costs of weed suppression for major land management agencies and estimates for the private cropland operators for North Dakota, 1978.*

Group	Suppression cost (nearest thousand)
N.D. State Highway Department	$ 230,000
Railroads (8,109 km)	625,000
County and township roads[a]	265,000
U.S. Fish and Wildlife Service	80,000
N.D. Game and Fish Department	15,000
U.S. Bureau of Reclamation	12,000
U.S. Forest Service	89,000
Private land operators[b]	25,023,000

[a]Based on a three-county average.

[b]Based on 10,009,100 lb of product (Nalewaja et al. 1980) × estimated average costs of $2.50/lb in 1978.

mammals (Table 14). Vegetative characteristics of these species were life-form — 21 forbs and 4 grasses; growth habit — 18 annuals, 5 perennials, and 2 biennials; and origin — 16 introduced and 9 native species. Only three native perennial species (forbs) occurred on earth mounds. Only 1 species representative of the regulated noxious weed group and 10 species of the problem cropland weed group were present.

Table 13. *Common names of 44 plant species that occurred within stands of seeded nesting cover but not within quadrats.*

Black-eyed susan[a]	Northern gentian
Black nightshade	Orchardgrass
Blue stickseed	Perennial sow thistle
Bracted vervain	Pink cockle
Broomweed	Prairie bird's-foot-trefoil
Canada anemone	Prickly pear cactus
Canada wild rye	Red osier
Catnip	Reed canarygrass
Common motherwort	Rock cress
Common mullein	Russian olive
Cut-leaved nightshade	Shepherd's purse
Daisy fleabane	Showy locoweed
False dandelion	Slender milkvetch
Fescue sedge	Smallflower wallflower
Field mint	Stinging nettle
Gaura	Timothy
Green sagewort	Violet wood sorrel
Hairy golden aster	Western wheatgrass
Hedge mustard	Wild rhubarb
Little bluestem	Willow-leaved dock
Musk thistle	Wormseed wallflower
Northern bedstraw	Yellow whitlowort

[a]Scientific names appear in Table A-3.

Table 14. *Common names of 25 plant species that occurred on earth mounds made by pocket gophers and badgers.*

Annual sunflower[a]	Rock cress
Canada thistle	Russian thistle
Common pigweed	Tumbling mustard
Cut-leaved nightshade	Upright yellow wood sorrel
Dog mustard	Western ragweed
Field mustard	White cockle
Flixweed	White sweet clover
Frenchweed	Wild buckwheat
Japanese brome	Wild oat
Kochia	Witchgrass
Lamb's quarters	Yellow foxtail
Marsh elder	Yellow sweet clover
Peppergrass	

[a]Scientific names appear in Table A-3.

Vegetation associated with areas skipped during planting. — Thirty-three plant species occurred on areas left unseeded when SNC was established (Table 15). Vegetative characteristics of these species were life-form — 28 forbs and 5 grasses; growth habit — 20 annuals, 10 perennials, and 3 biennials; and origin — 23 introduced and 10 native species. There were only three native perennial species, one grass, and two forbs. Three species were representative of the regulated noxious weed group and 13 species were of the greater problem cropland weed group.

Areas skipped during planting did not completely revegetate with SNC mixture species but were colonized by other plant species in the first 9 subsequent years. Skips left by drilling operations had obvious boundaries (Fig. 9) whereas skips left by aerial or ground broadcast operations had vague boundaries and were usually more pronounced

Table 15. *Common names of 33 plant species that occurred on areas left barren during planting operations.*

Annual sunflower[a]	Peppergrass
Blue stickseed	Perennial sow thistle
Blue wild lettuce	Prickly lettuce
Canada thistle	Purslane
Cheatgrass	Russian thistle
Common dandelion	Smooth catchfly
Common pigweed	Sow thistle
Curly-cup gumweed	Thymeleaf euphorbia
Curly dock	Tumbling mustard
Dog mustard	Western dock
Field mustard	Western ragweed
Flixweed	White cockle
Frenchweed	Wild barley
Horseweed	Wild buckwheat
Japanese brome	Wild oat
Kochia	Yellow foxtail
Lamb's quarters	

[a]Scientific names appear in Table A-3.

Fig. 9. An area skipped during drilling operations retained an obvious boundary and did not revegetate with seeded species during the first five growing seasons.

(Fig. 10). Skips left by single broadcast operations, as opposed to double broadcast operations perpendicular or diagonal to each other, were fringed in appearance, apparently due to the greater distances the smaller and heavier alfalfa and sweet clover seeds broadcast as compared with the lighter and larger grass seeds. Canada thistle, western dock, wormwood, curly dock, and sow thistle were mainly responsible for the contrasting appearance of the skips and the lack of continuity in the natural coloration of areas where grasses were absent.

Discussion and Management Inferences

Seeded nesting cover has been commonly referred to as forage or tame hayland by farmers and ranchers; as wildlife cover, tall dense rank cover, or dense nesting cover by wildlife resource agencies; and as land retirement cover or wildlife cover plantings on privately owned land by

Fig. 10. An area skipped during broadcasting operations had a vague boundary and did not completely revegetate with seeded species during the first five growing seasons.

various agricultural agencies. Emphasis in this discussion is placed on the relation of SNC to the production of wildlife, primarily upland nesting waterfowl and game birds, and to land being managed within the National Wildlife Refuge System.

Residual Cover in Spring

Kirsch et al. (1978) reported on a direct relation between increasing duck nest densities and success of clutches and increasing visual obstruction of residual vegetation in spring. In view of their data, the potential for maximum production of most species of upland nesting ducks should be anticipated in the taller and denser residual vegetation and likewise, higher measurements of plant height and visual obstruction should be predictive of stand performance and of the potentiality of higher wildlife outputs.

Results of the present study indicate that the maximum vegetation growth for individual SNC stands can be identified by visual obstruction and height measurements of residual vegetation in spring. A stand apparently reaches maximum growth in only 1 of the first 10 years. Stands usually reach their maximum growth during either the third, fourth, or fifth growing season but the specific year in which a stand will reach its maximum growth is too variable to predict. Stands also tend to degenerate in height and visual obstruction value after the year of maximum growth. The degeneration does not always occur in a predictable pattern and, as with the year of maximum growth, several environmental factors contribute to this variability. Precipitation apparently affected stand growth and performance the most, especially the amount received in the year before spring measurements and the amount of snow and ice received in the previous winter.

The effect of individual SNC species on visual obstruction and height measurements varied in spring. Tall wheatgrass provided greater visual obstruction than intermediate wheatgrass, slender wheatgrass, or quackgrass, principally because of greater plant height, better retention of standing dead seed stalks for at least 3 years, and the clumpy bunchgrass form. Sweet clovers, on the other hand, provided the tallest cover, just over 3 m in a stand, but visual obstruction was not as great as for grasses because of lower plant densities. Red clover and alfalfa provided poorer visual obstruction than grasses in spring because of their greater tendency to lodge.

Unlike a standing crop of live vegetation in summer, residual SNC in spring has been subjected to overwinter compaction and fracturing, harvesting by animals, and decomposition. Although residual SNC measurements in spring do not represent the truest aspect of stand performance from a previous growing season, during an average winter they should represent a relative reflection of the structural qualities. In 2 of 3 years, representative performance of stands was mostly negated by ice, heavy snowpack, or a combination of snowpack and harvest by rodents. Such events, if frequent, would therefore negate the possibility of setting minimum visual obstruction or plant height goals for vegetation or wildlife management purposes. For example, if a minimum threshold of 1.5 dm for total visual obstruction had been set as a decision point for vegetation management purposes in this study, treatments would have been applied to 23% of the sampled SNC stands in 1977, 93% in 1978, and 77% in 1979. Furthermore, 22% of the same stands that would have received treatment (<1.5 dm) in 1978 would not have needed treatment (>1.5 dm) in 1979, a case in point of a potentially unnecessary and excessive treatment effort in 1978. In some instances, a stand that is poor initially may never provide visual obstruction above a set threshold value for management purposes.

There are no known published minimum values relating visual obstruction of residual vegetation to wildlife outputs. However, preliminary results from related studies at Northern Prairie Wildlife Research Center indicate that minimum values vary in range by species or groups of species; average minimum values for mallards (*Anas platyrhynchos*) have been high compared with low average values for upland sandpipers (*Bartramia longicauda*).

Vegetative Cover in Summer

Changes in structural features of SNC, including canopy cover, species composition, life-form, and number of species were greatest during the first three growing seasons and fairly constant during the next six growing seasons. When stands were properly established (Duebbert et al. 1981), the planted species dominated most stands for at least 10 years. Successful establishment of a stand was usually apparent in the second growing season. During the second growing season, SNC should be a fairly continuous but open crop with sweet clovers as the dominants, and intermediate wheatgrass, tall wheatgrass, and alfalfa as the subdominants. The stand should also contain an assortment of annual forbs. During the third growing season, SNC should be dominated by a dense crop of intermediate wheatgrass, tall wheatgrass, and alfalfa and the stand should be intermixed with dead sweet clover stalks. Grasses should make up about 60–80% of the cover in the third growing season.

Occasionally SNC stands showed no evidence of successful establishment in the second growing season because of the effects of drought, weed dominance, or improper seeding. During the third growing season, these stands would either become established, usually with a sparse mix of SNC, or they would become dominated by undesirable species of grasses and forbs. In either instance, a management decision for either retaining or replacing the stand is possible during the second or third growing season.

The SNC composition seems to progress slowly in favor of grasses on good sites and alfalfa on poor or sandy sites. However, stands dominated by alfalfa (>70% coverage) remained dominated by alfalfa. The percentage of grass

component in SNC directly affected visual obstruction measurements. Duebbert et al. (1981) suggested that canopy cover in an established stand should be about 75% grasses and 25% legumes. They also provided seeding guidelines that were directed toward achievement of this ratio of grasses to legumes. In Montana Dubbs (1975) found that (1) grasses were tallest when grown with a legume, (2) mixtures of grass and alfalfa yielded on the average 3.7 times more forage than grasses seeded in pure stands, and (3) grass mixtures usually were no more productive than pure stands of grass and should be planted only for some special purpose. Management of cover for wildlife should be viewed as a special-purpose effort. Mixed or pure stands of grasses are probably the best management option for sites with heavy infestation of noxious weeds or high densities of pocket gophers. In contrast to stands dominated by grass, stands dominated by alfalfa usually showed extreme fracturing and lodging and consistently poorer visual obstruction. On the other hand, stands dominated by tall wheatgrass provided higher visual obstruction than those dominated by intermediate wheatgrass or the pubescent variety of intermediate wheatgrass (*A. i. trichophorum*). Tall wheatgrass was also more tolerant of saline soils. Unlike smooth brome, intermediate and tall wheatgrass did not invade habitats adjacent to SNC stands.

In addition to SNC, native plant species and shrub or tree seedlings were a part of the initial floristic composition (Egler 1954). Annual ring counts of shrub and tree saplings from older age-class stands of SNC indicated that they were established in the first or second growing seasons. The presence of large shrubs and tree saplings was noticeably more pronounced in stands near shelterbelt plantings and in areas of 45 cm or more of annual precipitation. Although native plant species were present in SNC stands during all of the first 10 growing seasons, patterns of succession toward dominance by these species were evidently masked by the vigor of SNC. Therefore, the use of native plant species as well as shrubs or trees is mostly negated for predicting successional patterns and the times of treatment for management of SNC.

Problem Related Species

Undesirable and invader species were not consistent features of SNC stands but were present in some individual stands. Older stands with few species present other than the SNC mixture were generally stands with a history of intensive chemical and tillage management, of proper establishment procedure, and of few fossorial rodents. These stands were the result of good farming practices by managers and cooperative farmers and were a definite asset to the SNC resource units.

Nearly all stands had at least one species present that could be classified either as a noxious weed, a problem farm weed, or a nuisance weed. Problem-related plant species were usually local in nature and not concomitant with the objectives of SNC management. The worst concentrations of problem weeds in the SNC stands were seen on or around former farmyard, corral, and barn sites, on winter livestock feeding sites, or on sites with excessive manure accumulations. A regional guide for multiple or single species control is not presently available. In some instances use of herbicides to suppress weeds adversely affects the SNC mixture by removing alfalfa and sweet clover. In other instances alfalfa attracts pocket gophers and indirectly aids weed infestation of SNC through weed establishment on mounds. For areas with a concentrated broad-leaved weed problem, replacement of the SNC mixture with a mixture of grass species only would permit intensive use of herbicides and would also be less attractive to pocket gophers.

Many of the more obvious weed species are temporarily subdued in SNC stands by annually mowing, flailing, burning, or swathing. Considerable amounts of public monies and manpower, much of which may result from unjustifiable complaints made by individuals or by local weed commissioners, are being used on these weed problems. Several weed species, which are not regulated noxious weeds, also provide benefits to wildlife. Leafy spurge, wormwood, Canada thistle, musk thistle, and plumeless thistle necessitate special management on public lands. The weed problem on public land or, more specifically, the threat of a small reservoir of problem weeds on public lands to adjoining private lands, many of which already receive intensive weed tillage and herbicide treatments annually, needs to be addressed to a greater extent in the near future.

Stand Longevity

The useful life expectancy of SNC was not determined in this study, but a few stands have retained their SNC species composition after 10 years of nontreatment. The quantities of wildlife production and attractiveness to SNC stands 8 years old or less have been well documented (Duebbert 1969; Duebbert and Kantrud 1974; Duebbert and Lokemoen 1976, 1977, 1980), but the same quantities for older stands of SNC are unknown. However, substantial waterfowl nest densities and production have been found in older stands dominated by smooth brome and with a haying history. These stands ranged in age between 15 years (Vorhees and Cassel 1980) and 20 years (A. T. Klett, unpublished data). It seems probable, then, that SNC on good sites could also produce substantial quantities of wildlife for 15 years or longer.

During the time of initial evaluations of SNC (late 1960's–early 1970's), the concern of an energy crisis of fossil fuels had not yet been advanced to the alarm and conservation stage of the present. Likewise, stand quality or longevity was a minor concern to land managers and administrators because many of the extensive wildlife

cover and cropland retirement programs were funded or contracted for a definitive term (either 5 or 10 years). At the end of this term, stands were usually replaced with grain crops until the need for establishment of another cover crop was apparent. In light of an ever diminishing supply of fossil fuel energy, management for quality and longevity of vegetative cover is needed for much of the public land where production of grain is not one of the key objectives. One of the better and longest-lived replacement plant communities would likely be a mixture of native species from the same general area. Unfortunately, seed sources for such mixtures are hard to obtain and they are prohibitively priced for extensive cover programs for the glaciated prairie pothole region. Furthermore, the wildlife production capabilities from planted stands of cultivars of native plant species is virtually unknown. Thus until significant seed sources and proper procedures are obtained for stand establishment and subsequent management of mixtures of native plant species, SNC and similar inexpensive and easy-to-establish mixtures will continue to be important for use in large-scale wildlife management and agricultural grain deferment programs and on sites where long-term efforts needed to reestablish native cover would be inappropriate.

Guidelines

Seeded nesting cover is only one among several possible types of replacement plant communities adaptable to the Northern Plains. It is a cover crop that can be grown on lands within a precipitation range of 30–61 cm and for soils of capability class IV or better.

Compared to other grasses or grass–legume mixtures, SNC is economical and easy to establish, which makes it a desirable mixture for use on extensive public land programs or for wildlife management programs where the production:cost ratio is often narrow and the range of establishment methods is broad. Another desirable feature of SNC is the low potential for species invasion into adjacent habitats; however, within individual stands, if proper establishment procedures are not followed, unsown areas will produce undesirable weeds instead of SNC.

For establishing and managing SNC, energy conservation is dependent on stand longevity. Good stand quality (species composition) and stand longevity are related to proper establishment and management procedures and to environmental conditions. The goal of SNC management should therefore be quality-oriented.

The main decision periods in SNC management are during stand establishment (first 3 years) and after stand establishment. Decision guidelines for qualitative management of SNC for these periods are suggested as follows:

- Prepare the soil and plant the SNC seed mixture according to the procedures described by Duebbert et al. (1981).
- Inspect each stand for success of SNC establishment and for noxious weed invasion during the first, second, and third growing seasons.
- If SNC species appear to dominate stands of cover during the second and third growing seasons and noxious weeds are not an apparent problem, quality stands of SNC have been established.
- If SNC species are rarely apparent in the second and third growing seasons and weed species are dominant, these stands should be eliminated and soil preparations and establishment procedures should be started over. This decision can be made in the second growing season, if growing conditions have been favorable and the amount and distribution of annual precipitation have been average or above during the previous year or two.
- If SNC species dominate stands of cover during the second and third growing seasons, yet stands also have an apparent heavy noxious weed infestation, managers have the options of controlling the weeds with herbicides, temporarily subduing the weeds with mechanical equipment which may enhance the dominance of SNC species in the future, or eliminating the stand by cultivation. The choice of these options should be based on the quantity and dispersion of noxious weed species within stands and on the degree of difficulty and cost for controlling or subduing the target weed species.

The SNC stands that have been successfully established on good sites can be expected to provide substantial structure for at least the first 6 growing seasons and to retain SNC composition for at least the first 10 growing seasons and probably longer for most stands.

- Except for regulated noxious weed control, there should be no management treatments of SNC stands during the first six growing seasons.
- Periodic checks for stand performance and invasion by regulated noxious weeds should be made on stands 7 or more years old. Beginning with the seventh growing season, vegetation in some stands may need a rejuvenation treatment. An array of treatments and times for application are suggested for sown mixtures of cool-season grasses and legumes by Duebbert et al. (1981); however, decisions for treatments should be avoided in years of extremely abnormal conditions such as drought, excessive wetness, excessive harvest by rodents, or heavy snow or ice pack. Treatment decisions should also be avoided in the first growing season following any abnormal condition. Substantial increases in vegetation structure, vigor, and seed production in SNC have been seen following abnormal conditions. In effect, an abnormal condition produces a vegetative renovation action similar to an applied treatment.

Evaluation studies of wildlife outputs and the development of vegetation management guidelines for SNC stands which are more than 8–10 years old are lacking. Such studies are needed and should be conducted in the near future on a sample of older age-class stands. Furthermore, there is a definite need for more studies of methods of SNC renovation.

Conclusions

Structural changes in species composition, canopy cover, plant height, and visual obstruction of cover are measurable in stands of SNC of different ages. Evidently these changes are not statistically different relative to age when stands from over a broad region are pooled, but they show general trends of improvement, year of maximum growth, and general trends of degeneration. Thus, the variability in these changes suggests that any practical management decisions, relative to stand age, must be made on an individual field basis rather than on all stands as a whole.

The influences of climate and environment on vegetational changes and trends are dominant factors. The influence of precipitation received in the last year before measurements and of the deterioration caused by excessive snowpack, ice pack, or harvesting by rodents surpasses the influences of stand age, production capabilities of soils, and species composition on the height and visual obstruction of SNC in spring. Under a more moderate and consistent climate, detection of age-related differences in residual vegetation structure in spring may be possible, but the erratic climate of the glaciated prairie pothole region will negate this possibility in many years.

Species composition, number of species, and canopy cover are more consistent from year to year within stands than they are among stands, but there is also a high degree of annual variation in these same structural characteristics within stands. Furthermore, obvious distinctive patterns of secondary succession are basically lacking during the first nine growing seasons in seeded nesting cover.

The relations among stand age, vegetation structure, climate, and secondary succession are very complex. These relations were not fully identified during this study; however, their relative importance to measurements of visual obstruction and plant height and, indirectly, of potential wildlife production, are readily understood when considerations are made for variable climatic and site conditions.

The SNC, as described in this paper, is a manageable cover crop that can be used throughout the glaciated prairie pothole region of the north central United States and throughout much of the Aspen Parkland Biome of Alberta, Saskatchewan, and Manitoba, Canada. It is neither the last in a series of possible replacement plant communities nor the ultimate cover for the diversity of wildlife species that inhabit the Northern Plains; nevertheless, it is a crop with a proven ability to produce a stand of man-made cover with a structural form that is both attractive and secure for many species of birds and mammals.

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APPENDIX

Table A-1. *Bird species known to nest in stands of seeded nesting cover.*

Common name	Scientific Name	Common name	Scientific Name
American bittern	*Botaurus lentiginosus*	Lesser scaup	*Aythya affinis*
American wigeon	*Anas americana*	Mallard	*Anas platyrhynchos*
Baird's sparrow	*Ammodramus bairdii*	Marbled godwit	*Limosa fedoa*
Blue-winged teal	*Anas discors*	Marsh hawk	*Circus cyaneus*
Bobolink	*Dolichonyx oryzivorus*	Mourning dove	*Zenaidura macroura*
Brown-headed cowbird	*Molothrus ater*	Northern shoveler	*Anas clypeata*
Clay-colored sparrow	*Spizella pallida*	Pintail	*Anas acuta*
Common yellowthroat	*Geothlypis trichas*	Redhead	*Aythya americana*
Dickcissel	*Spiza americana*	Red-winged blackbird	*Agelaius phoeniceus*
Gadwall	*Anas strepera*	Ring-necked pheasant	*Phasianus colchicus*
Grasshopper sparrow	*Ammodramus savannarum*	Savannah sparrow	*Passerculus sandwichensis*
Gray partridge	*Perdix perdix*	Sharp-tailed grouse	*Pedioecetes phasianellus*
Greater prairie chicken	*Tympanuchus cupido*	Short-billed marsh wren	*Cistothorus platensis*
Green-winged teal	*Anas crecca*	Short-eared owl	*Asio flammeus*
Killdeer	*Charadris vociferus*	Upland sandpiper	*Bartramia longicauda*
Lark bunting	*Calamospiza melanocorys*	Vesper sparrow	*Pooecetes gramineus*
LeConte's sparrow	*Passerherbulus caudacutus*	Western meadowlark	*Sturnella neglecta*

Table A-2. *Status of USDA agreements on seeded nesting cover carried out under the Water Bank Program in the glaciated prairie pothole region, 1972 through 30 September 1978.*

State	Number of agreements	Wetland		Upland		Total	
		Hectares	Acres	Hectares	Acres	Hectares	Acres
North Dakota	1,456	23,140	57,136	57,195	141,222	80,335	198,358
South Dakota	838	10,791	26,645	38,592	95,289	49,383	121,934
Minnesota	1,233	7,064	17,441	20,103	49,638	27,167	67,079
Montana	107	1,034	2,553	4,234	10,455	5,268	13,008
Total	3,634	42,029	103,775	120,124	296,604	162,153	400,379

Table A-3. *Scientific and common names of plants.*

Common name	Scientific name	Growth[a] habit information
Alfalfa	*Medicago sativa* L.	FPI
American vetch	*Vicia americana* Muhl.	FPN
Annual sunflower	*Helianthus annuus* L.	FAN
Black-eyed susan	*Rudbeckia hirta* L.	FBN
Black medic	*Medicago lupulina* L.	FAN
Black nightshade	*Solanum americanum* Mill.	FAI
Blue stickseed	*Lappula echinata* Gilib.	FAI
	Lappula redowskii (Hornem.) Greene	FAI
Blue wild lettuce	*Lactuca oblongifolia* Nutt.	FPN
Box-elder	*Acer negundo* L.	TPN
Bracted vervain	*Verbena bracteata* Lag. & Rodr.	FPN
Broomweed	*Gutierrezia sarothrae* (Pursh) Britt. & Rusby	FPN

Table A-3. Continued.

Common name	Scientific name	Growth[a] habit information
Buckbrush	*Symphoricarpos occidentalis* Hook.	SPN
Bull thistle	*Cirsium vulgare* (Savi) Ten.	FBI
Bushy smartweed	*Polygonum ramosissimum* Michx.	FAN
Butter and eggs	*Linaria vulgaris* Hill	FPI
Canada anemone	*Anemone canadensis* L.	FPN
Canada thistle	*Cirsium arvense* (L.) Scop.	FPI
Canada vetch	*Astragalus canadensis* L.	FPN
Canada wild rye	*Elymus canadensis* L.	GPN
Catnip	*Nepeta cataria* L.	FPI
Cheatgrass	*Bromus tectorum* L.	GAI
Common dandelion	*Taraxacum officinale* Weber	FPI
Common evening primrose	*Oenothera strigosa* (Rydb.) Mack. & Bush	FBN
Common milkweed	*Asclepias syriaca* L.	FPN
Common motherwort	*Leonurus cardiaca* L.	FPI
Common mullein	*Verbascum thapsus* L.	FBI
Common pigweed	*Amaranthus retroflexus* L.	FAI
Common plantain	*Plantago major* L.	FPI
Crested wheatgrass	*Agropyron cristatum* (L.) Gaertn.	GPI
Curly-cup gumweed	*Grindelia squarrosa* (Pursh) Dun.	FBN
Curly dock	*Rumex crispus* L.	FPI
Cut-leaved nightshade	*Solanum triflorum* Nutt.	FAN
Daisy fleabane	*Erigeron strigosis* Muhl.	FAN
Dalea	*Dalea leporina* (Ait.) Bullock	FAN
Dog mustard	*Erucastrum gallicum* (Willd.) Schulz	FAN
Dogbane	*Apocynum cannabinum* L.	FPN
Dragonhead	*Dracocephalum parviflorum* Nutt.	FPN
False dandelion	*Agoseris glauca* (Pursh) D. Dietr.	FPN
Fescue sedge	*Carex brevior* (Dew.) Mack.	GPN
Field bindweed	*Convolvulus arvensis* L.	FPI
Field mint	*Mentha arvensis* L.	FPN
Field mustard	*Brassica kaber* (DC.) Wheeler	FAI
Flixweed	*Descurainia sophia* (L.) Webb	FAI
Fowl bluegrass	*Poa palustris* L.	GPN
Frenchweed	*Thlaspi arvense* L.	FAI
Fringed sage	*Artemisia frigida* Willd.	FPN
Gaura	*Gaura coccinea* Pursh	FPN
Giant ragweed	*Ambrosia trifida* L.	FAN
Golden dock	*Rumex maritimus* L.	FAN
Green ash	*Fraxinus pennsylvanica* Marsh.	TPN
Green needlegrass	*Stipa viridula* Trin.	GPN
Green sagewort	*Artemisia campestris* L.	FBN
Groundcherry	*Physalis virginiana* Mill.	FPN
Hairy four-o'clock	*Mirabilis hirsuta* (Pursh) MacM.	FPN
Hairy golden aster	*Chrysopsis villosa* (Pursh) Nutt.	FPN
Hedge bindweed	*Convolvulus sepium* L.	FPI
Hedge mustard	*Sisymbrium officinale* (L.) Scop.	FAI
Hoary cress	*Cardaria draba* (L.) Desv.	FPI
Hoary vervain	*Verbena stricta* Vent.	FPN
Horse nettle	*Solanum carolinense* L.	FPN
Horseweed	*Conyza canadensis* (L.) Cronq.	FAN
Intermediate wheatgrass	*Agropyron intermedium* (Host) Beauv.	GPI
Japanese brome	*Bromus japonicus* Thunb.	GAI
Kentucky bluegrass	*Poa pratensis* L.	GPI
Kochia	*Kochia scoparia* (L.) Schrad.	FAI
Lamb's quarters	*Chenopodium album* L.	FAI
Large goatsbeard	*Tragopogon dubius* Scop.	FBI
Leafy spurge	*Euphorbia podperae* Croizat	FPI
Little bluestem	*Andropogon scoparius* Michx.	GPN
Long-headed coneflower	*Ratibida columnifera* (Nutt.) Woot. & Standl.	FPN
Long-rooted smartweed	*Polygonum coccineum* Muhl.	FPN
Maple-leaved goosefoot	*Chenopodium hybridum* L.	FAN
Marijuana	*Cannabis sativa* L.	FAI

Table A-3. Continued.

Common name	Scientific name	Growth[a] habit information
Marsh betony	*Stachys palustris* L.	FPI
Marsh elder	*Iva xanthifolia* Nutt.	FAN
Maximilian sunflower	*Helianthus maximiliana* Schrad.	FPN
Musk thistle	*Carduus nutans* L.	FBI
Narrow-leaved goldenrod	*Solidago graminifolia* (L.) Salisb.	FPN
Needle and thread	*Stipa comata* Trin. & Rupr.	GPN
Night-flowering catchfly	*Silene noctiflora* L.	FAI
Northern bedstraw	*Galium boreale* L.	FPN
Northern gentian	*Gentianella amarella* (L.) Borner.	FAI
Orchardgrass	*Dactylis glomerata* L.	GPI
Pale smartweed	*Polygonum lapathifolium* L.	FAN
Panicled aster	*Aster simplex* Willd.	FPN
Pennsylvania smartweed	*Polygonum pensylvanicum* L.	FAN
Peppergrass	*Lepidium densiflorum* Schrad.	FAN
Perennial sow thistle	*Sonchus arvensis* L.	FPI
Philadelphia fleabane	*Erigeron philadelphicus* L.	FBN
Pink cockle	*Vaccaria segetalis* (Neck.) Gke.	FAI
Plumeless thistle	*Carduus acanthoides* L.	FBI
Poison ivy	*Toxicodendron rydbergii* (Small ex Rydb.) Greene	SPN
Prairie bird's-foot trefoil	*Lotus purshianus* Clem. & Clem.	FAN
Prairie goldenrod	*Solidago missouriensis* Nutt.	FPN
Prairie thistle	*Cirsium flodmani* (Rydb.) Arthur	FPN
Prairie wild rose	*Rosa arkansana* Porter	SPN
Prickly lettuce	*Lactuca serriola* L.	FBI
Prickly pear cactus	*Opuntia polyacantha* Haw.	SPN
Purslane	*Portulaca oleracea* L.	FAI
Quackgrass	*Agropyron repens* (L.) Beauv.	GPI
Red clover	*Trifolium pratense* L.	FPI
Red osier	*Cornus stolonifera* Michx.	SPN
Reed canarygrass	*Phalaris arundinacea* L.	GPN
Riddell's goldenrod	*Solidago riddellii* Frank.	FPN
Rock cress	*Arabis hirsuta* (L.) Scop.	FPN
Rough pennyroyal	*Hedeoma hispida* Pursh	FAN
Russian knapweed	*Centaurea repens* L.	FPI
Russian olive	*Elaegnus angustifolia* L.	TPI
Russian thistle	*Salsola iberica* Sennen & Pau	FAI
Shepherd's purse	*Capsella bursa-pastoris* (L.) Medic.	FAI
Showy locoweed	*Oxytropis splendens* Dougl.	FPN
Showy milkweed	*Asclepias speciosa* Torr.	FPN
Siberian elm	*Ulmus pumila* L.	TPI
Silky wormwood	*Artemisia dracunculus* L.	FPN
Silver leaf scurf pea	*Psoralea argophylla* Pursh	FPN
Skeleton weed	*Lygodesmia juncea* (Pursh) Hook.	FPN
Slender milkvetch	*Astragalus flexuosus* (Hook.) D.Don	FPN
Slender wheatgrass	*Agropyron caninum* (L.) Beauv.	GPI
Smallflower wallflower	*Erysimum inconspicuum* (Wats.) MacM.	FPN
Small-seeded false flax	*Camelina microcarpa* Andrz.	FAI
Smooth brome	*Bromus inermis* Leyss	GPI
Smooth catchfly	*Silene cseri* Baumb.	FBI
Smooth seed wild bean	*Strophostyles leiosperma* (T. & G.) Piper	FAN
Soft goldenrod	*Solidago mollis* Bartl.	FPN
Sow thistle	*Sonchus uliginosis* Bieb.	FPI
Stiff goldenrod	*Solidago rigida* L.	FPN
Stinging nettle	*Urtica dioica* L.	FPI
Strawberryweed	*Potentillia norvegica* L.	FAN
Switchgrass	*Panicum virgatum* L.	GPN
Tall goldenrod	*Solidago canadensis* L.	FPN
Tall smooth goldenrod	*Solidago gigantea* Ait.	FPN

Table A-3. Continued.

Common name	Scientific name	Growth[a] habit information
Tall wheatgrass	*Agropyron elongatum* (Host) Beauv.	GPI
Tansy mustard	*Descurainia pinnata* (Walt.) Britt.	FAN
Thymeleaf euphorbia	*Euphorbia serpyllifolia* Pers.	FAN
Timothy	*Phleum pratense* L.	GPI
Tumbling mustard	*Sisymbrium altissimum* L.	FAI
Upright yellow wood sorrel	*Oxalis stricta* L.	FPN
Violet wood sorrel	*Oxalis violacea* L.	FPN
Water horehound	*Lycopus americanus* Muhl.	FPN
Wavy-leaf thistle	*Cirsium undulatum* (Nutt.) Spreng.	FPN
Western dock	*Rumex occidentalis* Wats.	FPN
Western ragweed	*Ambrosia psilostachya* DC.	FPN
Western rock jasmine	*Androsace occidentalis* Pursh	FAN
Western wheatgrass	*Agropyron smithii* Rydb.	GPN
Western wild rose	*Rosa woodsii* Lindl.	SPN
White cockle	*Lychnis alba* Mill.	FPI
White prairie aster	*Aster ericoides* L.	FPN
White sage	*Artemisia ludoviciana* Nutt.	FPN
White sweet clover	*Melilotus albus* Desr.	FBI
Wild barley	*Hordeum jubatum* L.	GPN
Wild buckwheat	*Polygonum convolvulus* L.	FAI
Wild four-o'clock	*Mirabilis nyctaginea* (Michx.) MacM.	FPN
Wild licorice	*Glycyrrhiza lepidota* Pursh	FPN
Wild oat	*Avena fatua* L.	GAI
Wild rhubarb	*Arctium minus* Schkuhr	FBI
Willow-leaved dock	*Rumex mexicanus* Meisn.	FPN
Witchgrass	*Panicum capillare* L.	GAN
Wormseed wallflower	*Erysimum cheiranthoides* L.	FAN
Wormwood	*Artemisia absinthium* L.	FPI
Yarrow	*Achillea millefolium* L.	FPN
Yellow foxtail	*Setaria glauca* (L.) Beauv.	GAI
Yellow sweet clover	*Melilotus officinalis* (L.) Lam.	FBI
Yellow whitlowort	*Draba nemorosa* L.	FAI

[a]T = tree, S = brush or shrubs, F = forb, G = grass, P = perennial, B = biennial, A = annual, N = native, and I = introduced.

Table A-4. *Summation of residual cover measurements for 1977 stands of seeded nesting cover.*

Stand age (year)	Visual obstruction					Height				
	No. stands	No. measurements	$\bar{X}$	± S.D.	Range	No. stands	No. measurements	$\bar{X}$	± S.D.	Range
2	19	1,688	2.2	1.1	1.0–5.1	16	375	8.9	3.3	4.0–17.0
3	19	1,716	2.2	0.8	1.0–3.8	18	405	7.3	1.8	4.6–9.8
4	13	1,260	2.6	0.9	1.1–4.3	13	315	7.5	2.4	3.5–12.2
5	20	1,652	2.1	0.9	0.6–3.6	17	390	7.1	2.2	3.7–10.5
6	6	520	2.0	0.5	1.5–2.8	6	130	6.9	0.8	5.5–7.6
7	5	500	1.6	0.7	1.0–2.6	5	125	6.2	2.5	3.2–8.9
8	1	100	1.4	—	1.4	1	25	6.2	—	—

Table A-5. *Summation of residual cover measurements for 1978 stands of seeded nesting cover.*

Stand age (year)	Visual obstruction					Height				
	No. stands	No. measurements	$\bar{X}$	± S.D.	Range	No. stands	No. measurements	$\bar{X}$	± S.D.	Range
2	8	645	0.5	0.3	0.2–0.8	7	175	6.2	1.9	3.3–8.3
3	31	3,000	1.0	0.4	0.2–2.2	29	700	6.0	2.1	2.0–9.6
4	27	2,631	0.7	0.3	0.3–1.6	27	681	4.6	1.9	2.4–8.9
5	23	2,200	0.9	0.5	0.1–2.0	23	550	5.3	2.0	2.5–9.9
6	26	2,270	0.8	0.3	0.5–1.7	24	580	5.1	1.8	1.9–8.3
7	13	1,300	0.9	0.3	0.3–1.6	13	325	4.5	1.6	2.1–6.6
8	8	800	0.9	0.3	0.7–1.5	8	200	5.2	1.7	2.1–7.0
9	2	125	0.7	0.0	0.7	2	50	5.2	0.6	4.8–5.6

Table A-6. *Summation of residual cover measurements for 1979 stands of seeded nesting cover.*

Stand age (year)	Visual obstruction					Height				
	No. stands	No. measurements	$\bar{X}$	± S.D.	Range	No. stands	No. measurements	$\bar{X}$	± S.D.	Range
2	7	700	1.3	0.4	0.8–1.9	7	175	8.1	1.8	5.7–10.8
3	14	1,400	1.2	0.7	0.5–3.3	14	350	7.5	1.9	5.3–11.7
4	30	3,000	1.2	0.3	0.7–2.0	29	750	5.4	1.6	1.9–8.7
5	26	2,600	1.3	0.7	0.5–3.4	26	650	6.5	2.3	2.7–10.9
6	22	2,200	1.1	0.4	0.4–1.8	22	550	5.6	1.5	4.1–9.5
7	26	2,500	1.2	0.4	0.6–2.5	26	625	5.8	1.9	2.6–9.1
8	11	1,100	1.2	0.3	0.8–1.7	11	275	5.1	1.2	2.8–6.6
9	7	640	1.4	0.5	0.7–2.4	7	160	6.3	2.1	2.4–9.1
10	1	100	0.6	—	0.6	1	25	4.1	—	—

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A list of current *Special Scientific Report — Wildlife* follows.

225. Scalation of the American Alligator, by Charles A. Ross and Charles D. Roberts. 1979. 8 pp.

(Reports 226 and 227 are in one cover)

226. Waterfowl Status Report, 1975, compiled and edited by James R. Goldsberry, Sharon L. Rhoades, Lonnie D. Schroeder, and Morton M. Smith. 1980. 86 pp.
227. Waterfowl Status Report, 1976, compiled and edited by William W. Larned, Sharon L. Rhoades, and K. Duane Norman. 1980. 88 pp.
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236. Waterfowl Status Report, 1977, compiled and edited by Carey S. Smith, Sharon L. Rhoades, and K. Duane Norman. 1981. 88 pp.
237. Waterfowl Status Report, 1978, compiled and edited by Albert N. Novara, Sharon L. Rhoades, Betty I. Hodges, and K. Duane Norman. 1981. 96 pp.
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239. Summary of Foreign Game Bird Liberations, 1969-78, b
240. Reliability of Kill and Activity Estimates in the U.S. Wat
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241. Residues of DDT, Dieldrin, and Heptachlor in Earthworm
D. Gish and Donald L. Hughes. 1982. 15 pp.